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Vol. 8 April, 1954 No. 4

Department of Agriculture, Stock and Fisheries,
Port Moresby

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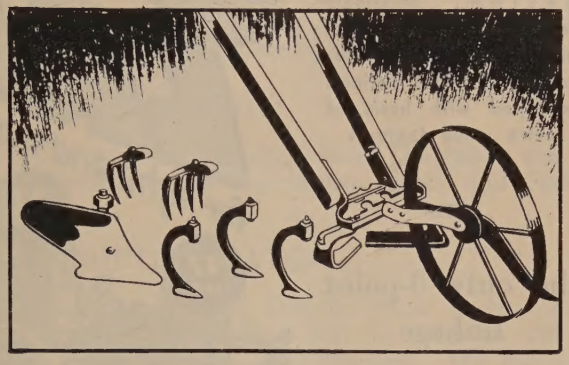

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FORMER ISSUES OF *GAZETTE*

The following numbers of the *Agricultural Gazette* have been issued :

New Guinea Agricultural Gazette—

Volume 1, Number 1.
Volume 2, Numbers 1, 2 and 3.
Volume 3, Numbers 1 and 2.
Volume 4, Numbers 1, 2, 3 and 4.
Volume 5, Numbers 1, 2 and 3.
Volume 6, Numbers 1, 2 and 3.
Volume 7, Numbers 1, 2, 3 and 4.

The Papua and New Guinea Agricultural Gazette—

Volume 8, Number 1.
Volume 8, Number 2.
Volume 8, Number 3.

Copies of all numbers of the *Gazette* to Volume 7, No. 4, are out of print.

NAME OF *GAZETTE* TO CHANGE

Subscribers, Libraries and Advertisers are notified that as from Volume 9, No. 1, July 1954, the name of *The Papua and New Guinea Agricultural Gazette* will be changed to *Papua and New Guinea Agricultural Journal*.

NOTES ON CACAO CAPSIDS IN NEW GUINEA

By G. S. Dun, B.Sc. Agr. *

Introduction.

THE history of Cacao in New Guinea goes back barely half a century, the first record of the export of processed produce in any quantity being in 1905. With only one or two minor exceptions, the New Guinea material was all brought in from Samoa, in German days, prior to the First World War.

Van Hall states that Criollo Cacao was brought from Ceylon to Samoa in 1883 and later in 1889 Forestero hybrids were imported from Ceylon. The nature of New Guinea Cacao derives through Samoa from Java, Ceylon, Trinidad and Venezuela and, according to Cheesman, it belongs to the Trinitario group and consists of hybrids from which one can obtain any type from a near-Criollo to something like pure *Theobroma leiocarpa.*

The New Guinea production has never played a major role in the Territory's economy and, indeed, prior to the Second World War, production was assisted by a bounty. With the marked world shortages after the war and the high prices being paid for cacao, planters in the Territory commenced to take a decided interest in the crop and during the past six years there has been a great increase in the area planted to cacao, although this has hardly had time yet to be reflected in the annual production figures.

With the sudden increase in the area under cacao, it would be surprising if new pests and diseases did not make themselves known as the trees matured. This has, in fact, happened and the following brief notes are intended to outline the new Cacao Capsid position as it stands to-day.

Original Outbreak.

First indication that cacao was being affected by a previously unknown pest occurred during the writer's absence from the Territory at the end of 1949. This occurred at Kabeira Plantation some 20 miles from Rabaul in New Britain. This cacao was rather severely war-damaged and a large proportion of it had died out or been completely destroyed. Here the first plantings had been made during the early 1930's and were continued until the Japanese invasion in 1941, by which time about 1,000 acres were under cacao. It is probable that the initial outbreak did not take place long before it was first noticed. During the financial year in which the Capsid was first observed the plantation suffered a drop in production of 60 per cent. It would not be possible to say how much of this should be ascribed, either directly or indirectly, to the insect, although it must have been responsible for the majority of this loss.

Species Involved.

Subsequent search, both on New Britain and the Mainland revealed several other species of Bryocorine Capsids which have been described by China and Carvalho (Bull. Ent. Res., Vol. 42 Pt. 2 p. 465). The results of their determinations and the current distribution of the various species, is as follows :—

1. *Parabryocoropsis typicus,* Ch. & Car. Gazelle Peninsula, New Britain.
2. *Parabryocoropsis duni,* Ch. & Car. Gazelle Peninsula, New Britain and Lae, New Guinea.
3. *Parabryocoropsis cheesmanae,* Ch. & Car. Kokoda, Papua.
4. *Pseudodoniella pacifica,* Ch. & Car. Gazelle Peninsula, New Britain.

Of the above species only (1) and (4) are at present of economic importance, (1) being more widely distributed but causing the same type of damage as

* Senior Entomologist, Department of Agriculture, Stock and Fisheries.

(4). *P. typicus* is distributed at all levels on the Gazelle Peninsula, while *P. pacifica* is only found in any numbers above 500 feet. *P. Cheesmanae* is an isolated record of a catch made at Kokoda many years ago. It is of limited significance at present as it was taken at an elevation of 1,800 feet which is largely beyond the height at which cacao can be successfully grown. However, that is no indication that it will not develop later in mainland plantations as they come to maturity.

The limited distribution of the various species, together with the relative hardiness of the early nymphal stages, has made the imposition of some Quarantine restrictions necessary. Unfortunately, all the cacao breeding and selection work in the Territory is carried out at Keravat where the principal Capsid, *P. typicus,* is particularly bad at times. At first, all seed going out was removed from the pods (in which virtually all oviposition occurs) and packed in sawdust prior to despatch. This proved to be unsatisfactory as delays in shipping and aircraft services frequently meant that it arrived at its destination after the seed had lost a lot of its viability or had even germinated. Now the pods are dipped in Phosfone-D.D.T. or a Toxaphene-D.D.T. wash which is less trouble, inexpensive and quite lethal to eggs or first instar nymphs.

Quite recently there has been an interesting development in the Capsid position in the find at Paili Plantation, Papua, of still a further species. It has been determined as *Helopeltis clavifer* Walk. While the genus *Helopeltis* contains many species of economic importance on a particularly wide range of tropical crops and extends from the Gold Coast to Indonesia, it has not previously been recorded strictly speaking from New Guinea. As far as I am aware, *H. clavifer* has only been recorded in the New Guinea area from Japen Island in the Schouten Group off the north-west tip of Dutch New Guinea and then not in association with any economic crop.

The two Indonesian species of *Helopeltis, H. theivora* and *H. antonii,* attack, among other crops, Tea, Cacao, Cinchona, Coffee, Pepper, Ginger, Citrus and many legumes. It is highly probable that a similar position will eventually occur in New Guinea.

An interesting point in connection with the Papuan Capsid is that the cacao at Paili Plantation has only very recently come into bearing, a fact which would appear to indicate that the insect is widespread among the indigenous flora, but has not yet been given an opportunity of coming into contact with suitable crops of economic importance in New Guinea.

The only other Bryocorine Capsid in the Territory of which I am aware, is *Pachypeltis* sp., an insect which at times can cause quite severe shoot damage to Cinchonas at the Agricultural Department's Highland Experiment Station at Aiyura in New Guinea. In all probability, this species would attack cacao if it were available but, since Aiyura is located at a height of about 6,000 feet, the species is most likely strictly a highland one and may not be able to exist in the lowland cacao area. However, the likelihood of both *Helopeltis* and *Pachypeltis* attacking tea should be borne in mind.

Damage.

Unlike the West African Capsids, the local species attack the pods primarily, although *P. typicus* will attack the flush growth extensively, at times causing considerable dieback. The lesions produced are quite typical. While in the Gold Coast pod damage is not considered a serious problem, there are several factors operating in New Guinea which make the position rather different. In the case of shoot attack, the dieback is as yet uncomplicated by the entry of any pathogen such as *Calonectria.* Where the fruit is concerned, the Capsid population, for most of the year, appears to be considerably higher than it is in

West Africa. The number of feeding scars per individual (except immediately prior to, or after, ecdysis) usually varies from 40 to 80 per 24 hours so that, where a heavily infested tree occurs carrying from 10 to 40 Capsids, the amount of actual mechanical damage is very considerable. It has been our experience that the purely mechanical damage caused by feeding alone, except on pods relatively near to maturity, can cause the loss of many pods. However, an equal, if not greater, proportion of the loss is caused by secondary complications. A minor part of this is caused by entry into old lesions of some two dozen species of insects of various types—Tipulids, Anthribids, Curculionids, Bruchids, etc., which feed and breed there and hasten the breakdown of the pod. However, the larger proportion of the damage is caused by the entry of the secondary fungus, *Gleosporium* sp. which grows in and around the Capsid lesion and fructifies in the form of a raised pustule on the surface of the pod. This fungus has its most pronounced effect during the wet season, when the major part of the annual crop is present on the trees.

Even in the limited areas of cacao present at Keravat, the density of the Capsid population varies most markedly from one portion of a block to another. The conditions under which cacao is grown in New Guinea do not make for the development of typical "Capsid Pockets" as they occur in West Africa. However, there is a tendency for the insects to spread and recede in any one block, depending on whether the conditions are suitable or otherwise.

Accurate and consistent figures for fruit losses have not yet been attempted. Nevertheless, it would be safe to say that losses at Keravat Experiment Station would be of the order of 15-20 per cent., with some blocks, or portion of blocks, showing very much higher losses. Moderately accurate assessments, both on and off the Station, have shown losses running as high as 80 per cent. of the fruit currently carried. In some of these cases, population counts of trees heavily damaged have shown figures from 450 to more than 1,000 Capsids per 100 trees, so that the heavy feeding injuries, together with the follow-up losses caused by *Gleosporium*, necessarily cause heavy fruit losses.

Bionomics.

The only species which have been available locally in large enough numbers to allow any investigation of its bionomics is *P. typicus*. This species has proved to be a most difficult subject, especially in the adult stages, so much so that virtually no information is yet available about its habits, longevity, reproductive capacity, etc. Similarly, the egg stage could not be handled in the insectary. For this, it was necessary to confine random caught females on pods in the field, remove after 24 hours and examine daily until the eggs hatch—a very lengthy and not necessarily accurate process. The adult will oviposit fairly rapidly in young shoots in the insectary, but such eggs as were laid were difficult to handle.

Of the data obtained to date there appears to be little significant difference between the general life history details of the two sets of Capsids, West African and New Guinean. With *P. typicus*, the egg is of much the same type as *Sahlbergella*, etc., and is deposited in precisely the same manner. However, although *Parabryocoropsis* will oviposit under soft bark in the insectary, it shows no tendency to do so in the field as defruiting observations have shown. Apart from the adult, the basic life-history durations are as follows :—

Egg Stage	Average	14 days
	Minimum	12 days
	Maximum	17 days

Nymphal Stages	1st instar	.... 1-2 days
	2nd instar	.... 2-3 days
	3rd instar	.... 2-3 days
	4th instar	.... 2-3 days
	5th instar	.... 3-5 days

The nymphal stages will survive quite satisfactorily in even small test-tubes in the insectary while adults under similar conditions will survive only 24-48 hours. Caged in even quite large gauze cylinders in presumably suitable conditions in the field (15 in. x 10 in. enclosing a clean half to full-grown pod) very few adults survive more than four or five days and it is extremely seldom that both members of a mated pair will survive more than several days. The maximum period a mated female has been kept alive is eleven days in which twenty-six eggs were laid. It appears likely that it will be necessary to enclose whole branches complete with fruit to allow adequate flight room if any further information is to be obtained on these points.

The sex ratio shows a small preponderance of males on the average, although it is not unusual to find males outnumbering females by 4-5 to 1 on occasions.

Control.

For various reasons, work on the control of Cacao Capsids so far has necessarily had to be of an empirical nature. The problem of control is fundamentally different to that of the Gold Coast owing to the different nature of the cacao types in the two areas. This, plus the fact that the nymphs do not appear to move away from the pod on which they emerge (unless, of course, it has reached a stage of extreme deterioration or they are disturbed), makes the successful African expedient of applying a concentrated D.D.T. preparation at the point of ramification inapplicable locally.

In New Guinea, the fruit is borne at random through the tree which necessitates a complete internal coverage for effective control. Then again, mainly for reasons of rough terrain, the application of an insecticide in liquid form is a difficult proposition, although good control, especially of *Pseudodoniella pacifica,* has been obtained by the thrice-repeated application of 0.2 per cent. water-dispersible D.D.T. emulsion at reasonable cost. Theoretically, under Territory conditions, the application of the insecticide in dust form appears to be the simplest and most effective method tried yet. Proprietary BHC preparations have been satisfactory in this regard, judging empirically on reduction in numbers after application. However, more trials will have to be carried out yet before a firm recommendation can be put forward.

Allowing for the oviposition habits of *Parabryocoropsis* complete defruiting has once or twice been advocated, but this is too drastic for the Territory where picking proceeds at intervals all the year round. It has only been advised in areas just coming into bearing where fruit is not common and the amount of shoot damage is excessive.

Despite the fact that some hundreds of nymphs have been bred out during the past two or three years, there has been no sign of any internal parasite of the Capsid. Predatory action must be quite appreciable, although it is not possible to assess to what extent it prevails. The three main predators seen in action are an Attid Spider, Reduviid Bugs (*Pristhesanctus* spp.), and the "Kurukum", or Green Tree Ant (*Oecophylla smargdina*).

Conclusion.

Finally, it should be pointed out that the Cacao Capsid position in New Guinea is a very recent one and it is still in an extremely fluid state. It is not possible, therefore, to foretell how it will eventually develop.

In West Africa, although Capsids have been known and studied far more extensively and for much longer than they have in New Guinea, there is no strong indication that they have finally settled down to their permanent position as Cacao Pests.

There are still only two plantations in the Gazelle Peninsula where *P. typicus* has caused shoot and branch dieback to an extent sufficient to warrant concern. If this tendency continues, a process which may take many years, and if it is combined with a fungal infection such as that caused by *Calonectria* in West Africa, the position could become an extremely serious one.

REPORT ON A PLANT VIRUS DISEASE SURVEY IN THE TERRITORY OF PAPUA AND NEW GUINEA—PART I

(Manila Hemp)

C. J. MAGEE, M.Sc., D.Sc. (Agr.)

(Chief Biologist, N.S.W. Department of Agriculture.)

(Part I.—Manila Hemp. The following report by Dr. Magee arises out of a visit which he made to the Territory at the invitation of the Minister for Territories to make a specific survey of various diseases in Manila Hemp and a general survey of the various disease problems in the Territory.)

(Part II of Dr. Magee's report covering the general survey of various diseases will be published in the *Papua and New Guinea Agricultural Journal*, Vol. 9 No. 1.)

Acknowledgments.

THE writer desires to express his thanks for the co-operation and assistance given him in the survey referred to in Part I and Part II of this Report by Officers of the Administration of Papua and New Guinea. Special assistance was received from Messrs. R. E. P. Dwyer, C. C. Marr, L. A. Bridgland, W. L. Conroy, V. Conaghan, R. Harris, F. C. Henderson, E. Henty, W. J. Hughes, G. P. Keleny, A. Ovenstone, F. X. Ryan, A. J. Schindler, J. R. Vicary, G. Walker, C. Wood of the Department of Agriculture, Stock and Fisheries, and J. W. Womersley of the Department of Forests; from Mr. N. Blood of the Hallstrom Trust, and Messrs. Downs, Elliott-Smith, Greathead, Niall, Timperley and Seale of the Department of District Services. Thanks are also due to Mr. C. L. Anthony of the Department of Lands for provision of the map of the Mount Lamington District, and to the New South Wales Department of Agriculture for granting the writer leave of absence for the purpose of undertaking the survey.

Part I.

Report on a Disease Survey of Bananas and Abaca (Manila Hemp) in the Territory of Papua and New Guinea in Relation to the Establishment of the Abaca Industry in the Territory.

This survey was undertaken by the writer during July and August, 1951, on behalf of the Department of Territories, Commonwealth of Australia, with the aim of determining the incidence of the bunchy top disease of *Musa* spp. (edible bananas, wild bananas and manila hemp) in the Territory of Papua and New Guinea and to advise on the quarantine measures necessary to prevent the introduction of bunchy top into the Territory. The survey was prompted by the current world shortage of abaca—the premier marine cordage fibre, and approaches made by commercial interests to the Commonwealth Government and the Administration of the Territory to enter the abaca industry in the Territory.

For some years the Department of Agriculture, Stock and Fisheries of the Territory has been carrying out experiments on the suitability of land for this fibre. Several plots of abaca have been planted at the Keravat Experiment Station, near Rabaul, and small plots are also planted at the Agricultural Experiment Stations at Madang, at Bubia near Lae, at Buka (Bougainville) and at Namatanai (New Ireland). [It is understood that there are also small plantings of abaca at Yule Island (Papua) and at Pondo (New Britain).] Among the propositions made by commercial interests was the proposal to introduce to the Territory planting stock of the Tangongon variety of abaca from North Borneo. This raised with the Administration of the Territory the question of introducing the bunchy top virus from North Borneo (where it is known to be present in both abaca and bananas) and the great danger such an introduction would be to bananas, which in many parts of the Territory are the staple food of the Natives.

The survey was carried out for a period of five weeks, visits being paid to all parts of the Territory that could be reached by aircraft in the time available. Bunchy top is a relatively conspicuous disease in its virulent form and it was possible when travelling by motor vehicle or low-flying aircraft to judge the health of edible and wild *Musa* spp., but frequent surveys on foot were made in most areas. The widest surveys were carried out in the Gazelle Peninsula and the foothills and coastal plains of Mount Lamington, as these areas appeared likely to offer suitable soils and road development for the early establishment of an abaca industry.

It is not proposed to review generally the bunchy top problem of *Musa* spp., but for this purpose reference is made to the literature 3, 6, 7, 9, 10, 17 cited at the end of this report.

Areas Visited.

Port Moresby. (Port Moresby township, Bisianumu Agricultural Station, Mageri Agricultural Officers' Training School, Itikinumu and Sogeri Rubber Plantations, Teachers' Training School, Laloki Plant Introduction Station.)

Rabaul and Gazelle Peninsula. (Rabaul township, Pila Pila, Ratavul, Vunalir, Natawa, Tokeravat, Vuvu Mission, Napapa, Vunadidir, Tenaka, Raluana, Davaun, Pararua, Konga, Matupit, Vunapope, Nunga Nunga and Coast Road to Kubanga.)

Manus Island and Kavieng, New Britain. (Airstrips only.)

Bougainville. (Buka Agricultural Experiment Station.)

Lae. (Lae township, Bubia Agricultural Experiment Station, Bumbi Forestry School.)

Central Highlands. (Goroka, Nondugl, Kerawagi, Banz, Baiyer River, Mount Hagen, Korn Farm, Kainantu, Aiyura Agricultural Experiment Station.)

Wau and Bulolo. (Townships and all roads surveyed.)

Madang. (Township, Agricultural Experiment Station and surrounding roads.)

Wewak. (Airstrip only.)

Portion of Markham and Ramu Valleys. (By low-flying aircraft.)

Popondetta. (Popondetta Station, Higatura, Saiho, Sangara, Awala Road from Embi airstrip to Oro Bay, Aerial survey of roads to Point Killerton, Gona and Buna.)

Kokoda. (Airstrip, School and Kokoda Station.)

Incidence of Diseases.

Bunchy Top.—

No sign of bunchy top disease was seen in bananas in any part of the Territory. This must be regarded as fortunate since the disease is present in a number of neighbouring regions, e.g. Philippines, North Borneo, Bonin Islands, Fiji Islands and Ellice Island and there appears to have been, over the years, a number of separate introductions of bananas, e.g. the varieties, "Java" or Ladies Finger, Cavendish, Gros Michel and Rajah. At least two separate introductions were reported to have been made by the Allied Army during the War, namely Cavendish and Rajah to Korn Farm, Mount Hagen and Cavendish and Gros Michel to Bumbi, near Lae.

Close attention was given to the plots of abaca (*Musa textilis*) growing at the Agricultural Experiment Station at Keravat near Rabaul. The variety is an unnamed one and the history of its introduction is unknown since the records of the Experiment Station were destroyed during the war. It is presumed by the Officer-in-Charge of the Experiment Station to have been introduced from the Philippines about 1930 and at the time of the reopening of the Station in 1946 only a few surviving stools of abaca were found. From these stools and their progeny a number of plots of several acres each have been planted out. A view of the oldest plot planted in February, 1949, is shown in Fig. 1 and of the plot planted in December, 1950, in Fig 4.

No abnormal features were noticed in the plot shown in Fig. 1 and apart from the fact that the variety is one liable to crowded growth of suckers it appeared to be a type likely to be useful for cordage fibre production. The variety appears to be a vigorous one and the lengths of mature stem in most of the interior (and shaded) stools were twelve feet or more to the crown of foliage (Fig. 3).

An examination of the plots planted in December, 1950, and in February, 1951, revealed an abnormal habit of growth. Although the growth of most of the stools was fairly vigorous, the suckers of many, after commencing normally, developed a series of narrow leaves with chlorotic areas and other features which are typical of the symptoms of bunchy top in abaca. These symptoms are illustrated in Figs. 5 to 10 and in the opinion of the writer indicate that at some time in its history this variety of abaca has been infected with bunchy top. It is considered that the variety is carrying a chronic infection which affects the plants only during the early stages of growth.

At one time it was accepted that *Musa* spp., once they became infected with the bunchy top disease, developed the disease in acute form and never recovered. This is still the view regarding bunchy top infection of the Cavendish variety of banana but is now clear that the Veimama variety of banana and certain varieties

Fig. 1.

Plot of Abaca planted at Keravat Lowlands Experiment Station, Gazelle Peninsula, New Britain, in February, 1949. The soil and climate appear to suit this crop.

Fig. 2.

Showing the base of one of the stools in the foreground of Fig. 1. Note tendency to prolific sucker growth, which is considered to be a character of the variety.

Fig. 3.

View in interior of plot shown in Fig. 1 where some of the stems have been cut for fibre extraction. Many of the stems in the interior of the plot, under the influence of beneficial shade, are 12 feet or more to the crown of leaves.

Fig. 4.

Young plot of Abaca at Keravat Lowlands Experiment Station, planted in December, 1950, showing seven months' growth. The stool in the photo is typical of the best, many others were less advanced or less vigorous.

of abaca, following an acute phase of bunchy top infection, are able to make a partial recovery from the disease and the fact that they have been infected can only be determined with difficulty.

The interesting case of the Veimama banana was studied by the writer in some detail in 1938 and is discussed in " Transmission of Bunchy Top to Bananas " published in *Journal of the Australian Institute of Agricultural Science*, Vol. 14, No. 1, 18-24 of 1948. The degree of recovery that is attained by this variety may be judged by reference to Fig. 12.

Until the writer visited the estates of Borneo Abaca Ltd. at Tawau and Mostyn in North Borneo in October, 1950, it was accepted also that abaca (*Musa textilis*) succumbed severely to the bunchy top virus and did not recover. Evidence was found, however, in the North Borneo estates that this was not so. It was seen that following a period in which bunchy top spread in epiphytotic form through the estates, many stools of both the Tangongon and Bangkura varieties, after several months of acute development of the disease began to make a partial recovery, *in situ*, and if suckers were selected from such stools and replanted they made relatively vigorous growth with none of the acute symptoms of the disease. This behaviour of abaca had apparently not previously been noted by investigators in the Philippines where the crop is a major one, but reference to the Philippine literature (1, 2), indicates that attempts that were made there to rehabilitate the abaca industry are based on the selection of plants that had " survived " a bunchy top epiphytotic. It is the writer's opinion that the plants in question did not survive by resisting bunchy top but made a partial recovery following infection.

It is considered that the variety of abaca at Keravat Experiment Station, which presumably came from the Philippines, was derived from stock that had once suffered an attack of bunchy top. There is, in the writer's opinion, no

other explanation of the abnormal habit of growth of the plants in their juvenile stages.

The question arises whether such plants are still infectious and could become a source of virus to other *Musa* spp. in the Territory. Evidence of this was sought in the abaca plots at Keravat and in small plots, derived from Keravat stock, at Madang, Bubia and Buka, but none was found. Examination of neighbouring clumps of bananas and wild *Musa* spp. also did not indicate that natural spread had occurred. (It should be mentioned that the insect vector of the bunchy top virus—*Pentalonia nigronervosa*—is plentiful in Papua and New Guinea.) It would be reasonable to conclude that the Keravat stock is not a ready source of infection since it has been at the Station since about 1930 without giving rise to an outbreak of acute bunchy top in other *Musa* spp. which are fairly common in the neighbourhood. This would be consistent, too, with experience with partially-recovered Veimama bananas in New South Wales. In a plot of two acres of bananas which was planted at Duranbah, New South Wales, in 1938 for yield testing, alternate rows of Veimama, Cavendish and the recovering strain of Veimama grew together for a number of years without any sign of spread of the disease.

It would be premature, however, to conclude that the disease would not spread from the Keravat stock. It is not known whether the virus is actually attenuated or is narrowly localized to certain regions of the plant, for example the growing points. If it is attenuated there is the possibility of the attenuated virus mutating to a more virulent form and if it is merely localized there is the chance that this localization might break down. It is considered, therefore, that it would be unsafe for large acreages of the Keravat abaca to be planted out, as would be necessary in the establishment of abaca estates. As far as is known, bunchy top is not transmitted in the seed and it should be possible by raising seedlings and selecting them for type and vigour to regenerate the variety without the disease risk.

Fig. 5.

Plot of young Abaca, showing in foreground two suckers which after having developed to the broad leaf phase of sucker growth, proceeded to develop narrow leaves, with upturned margins and chlorotic areas in the laminae.

Fig. 6.

Showing the nature of the subsequent growth of abnormal suckers, and the chlorotic margin (which has become necrotic) usually shown by the last broad leaf before the narrow leaves appear.

Fig. 7.

Close up of abnormal leaf growth of suckers. Note the yellowish margin of the broad leaf on left of photo, followed by the appearance of three narrow leaves. The first narrow leaf to appear had a chlorotic margin which has become membranous under the action of the sun. Chlorotic areas were also present in the third narrow leaf to appear and these have collapsed to give an irregular lamina. A sequence of leaves of this type is typical of the symptoms of bunchy top in many varieties of abaca.

Fig. 8.

Showing the subsequent growth of suckers after the development of one or several narrow upright leaves with upturned margins. Two abnormal leaves were developed by this plant which then proceeded to make a " recovery ".

Fig. 9.

In some suckers the development of abnormal leaves is delayed until fairly late in growth. Note habit of the last two leaves of plant in centre foreground.

Fig. 10.
Illustrating the " leaf crimp " symptom which is shown by mature leaves of abaca plants which have " recovered " from bunchy top. This symptom is caused by each leaf being choked at its basal end as it emerges from the pseudostem.

Fig. 11.
Illustrating the dark brown streak or stripe which is a symptom of bunchy top in some varieties of abaca. (Quite distinct from the green streaks which are an important diagnostic symptom of bunchy top in the Cavendish and other varieties of bananas.) Caused by the accumulation of brown mucilage in the outer fibres of the mid-rib and leaf stalk. This symptom is often prominent in " recovered " plants of the Tangongon variety of abaca in North Borneo but was encountered only once in the variety at Keravat Lowlands Experiment Station.

Mosaic or Infectious Chlorosis of Musa spp.—

This virus disease, which is caused by a strain of Cucumber Mosaic virus (8, 14) was encountered in the Gazelle Peninsula, at Lae and at Madang. The disease has an acute form and a mild chronic form.

The mild chronic form was fairly widespread in edible bananas in Native villages in the Gazelle Peninsula, but its occurrences at Lae and Madang were restricted to a few localities. Yellow flecks and streaks in the leaves, which are not reduced in size, are the only effects of the chronic form of the disease. The chronic form of the disease is not regarded as serious, and where it is widespread it is considered that it has been propagated by suckers, rather than having been spread by its insect vector.

The acute form of the disease (Fig. 13) was seen on two occasions only in Native villages in the Gazelle Peninsula, where bananas were interplanted with European and Native vegetables. The disease is considered to have spread to the few banana plants which were affected by aphids (*Aphis gosypii*) and other species of aphids, which have migrated from one or other of the vegetable crops, e.g. cucumbers, squash, etc.

Fig. 12.

Stool of Veimama banana which has made a partial recovery from bunchy top, showing normal maturation of the bunch. Note vigour of sucker growth. (Duranbah, New South Wales, 1938.)

Fig. 13.

Mosaic or infectious chlorosis of bananas at Ratayul, near Rabaul. In its acute form, which is illustrated here, the virus (cucumber mosaic) causes intense chlorosis and marked reduction in size of leaves developed after infection takes place. A heart rot of the plant usually supervenes.

Reference is made to this disease here because of the possibility of some observers confusing its symptoms with those of the bunchy top disease. Plants that acquire the disease display symptoms like those shown in Fig. 13, and the affected plants, frequently develop heart rot and die down. Some of the surviving suckers may show pronounced yellow mottling of the foliage and are stunted, but others may show little effect on growth and only minor yellow flecking or streaking of the leaves. Mosaic is a relatively important disease of abaca in parts of the Philippines (14), but in those areas the cannas, weeds and grasses serve as reservoirs of the cucumber mosaic virus from which aphids spread the disease. It is of interest that in no part of the Territory visited were the weeds infected with this virus and in only one instance were cannas observed with mosaic.

Cercospora Leaf Spot.—

This disease, caused by the parasitic fungus *Cercospora musae* is to be seen in every part of the Territory except the Central Highlands of New Guinea, causing spotting of leaves and defoliation. Infection occurs where the leaves are young, mainly as they emerge from the pseudostem, but it is not till four or five weeks later, when the leaves are mature, that the spots appear. Thus, in actively growing plants, the impression is that the disease is not very destructive as there is a crown of apparently healthy leaves. After all leaves have emerged, however, the bunch is thrown and it is common for all leaves to die before the bunch is mature (Fig. 14). The disease reduces the quality of fruit but under present conditions of banana production in the Territory the disease is of little economic importance.

It is of interest, however, that the variety of abaca being grown at Keravat is highly resistant or immune to Cercospora leaf spot.

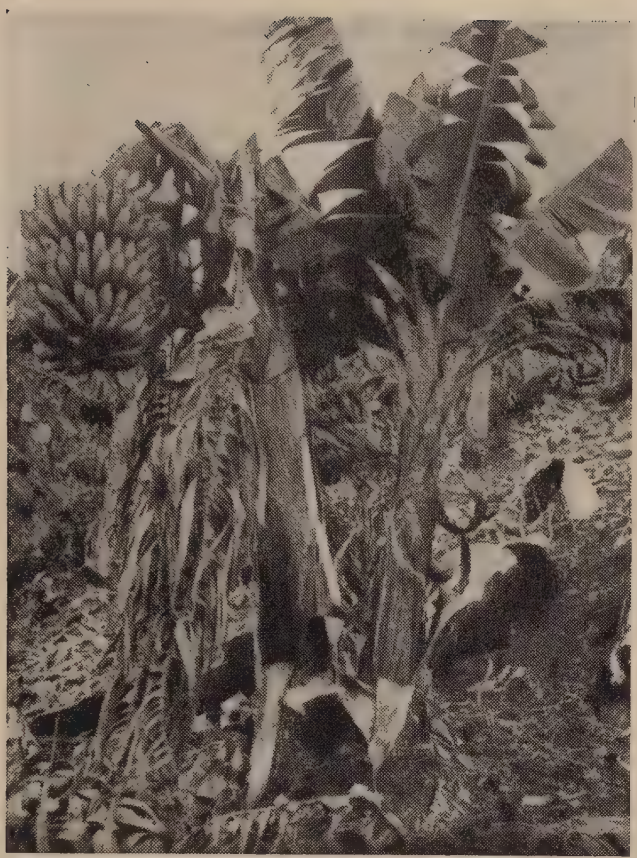

Fig. 14.

Showing the severe effects of Cercospora leaf spot on the Cavendish variety. The leaves become infected while young but the spots only develop as the leaves mature. After the bunch is thrown no further leaves are formed, and total defoliation often occurs before the fruit is mature.

Other Diseases of Musa spp.—

Although edible bananas are widely grown as a food crop throughout the Territory and wild seeded bananas are to be found in almost every jungle clearing, no serious disease of *Musa* spp., other than those discussed above was encountered during the survey.

Suggested Quarantine Measures in Connection with Musa spp.

Since, with the exception of the widespread development of Cercospora leaf spot, there is no other serious disease of bananas present in the Territory and because of the very great importance of bananas as a Native food crop, every effort should be made to maintain this position.

The two most important dessert bananas of the world, viz. Gros Michel and Cavendish, have already been introduced to the Territory and there should thus be no need to introduce further varieties to satisfy European palates. The Natives largely cultivate a wide range of apparently indigenous varieties (mainly cooking varieties) and there is unlikely to be a need to introduce other banana varieties for Native use.

It would seem, therefore, that the only request that the Administration might receive to introduce a species of *Musa* will be in connection with one or other of the various varieties of abaca (*Musa textilis*). These would be available from only a few parts of the world, viz. North Borneo, Malaya, Sumatra, and Central America. (There is an Ordinance prohibiting the export of plants or seeds of abaca from the Philippines.) The writer has not examined abaca in Sumatra or Central America, but it would be considered unsafe to introduce vegetative parts (suckers or bits) from either North Borneo or Malaya. The only vegetative planting material which would be available from these regions would be from stock which at some time in its history has had an attack of bunchy top and has made a partial recovery.

It is a fortunate feature that most virus diseases are not transmitted in the seed. The cases in which seed transmission occurs, e.g. certain viruses of the *Leguminoseae* and *Cucurbitaceae* are exceptional, and while there has never been an occasion to test experimentally the seed transmission of bunchy top by seeded *Musa* spp. it is the writer's opinion that such transmission is most unlikely. It is recommended, therefore, that if an approach is made to the Administration to introduce true seed of the variety Tangongon (one of the most favoured cordage varieties) the request be granted, provided the seed is grown in isolation and inspected soon after germination by a competent quarantine officer. It would be the safest procedure to make such an introduction through the Plant Introduction Station at Laloki, near Port Moresby, but other propositions for growth of introduced abaca seed in isolation are worthy of examination.

Regarding the plots of abaca at Keravat Experiment Station, Bubia, Madang, Buka and Namatanai, it is considered there should be no further vegetative propagation. The plots at Bubia, Madang and Buka, and at Namatanai if derived from Keravat stock, should be destroyed either by digging out or the use of hormones (5) and the same should be done with the plots of immature hemp at Keravat. The mature hemp at Keravat contains many tons of fibre and because of its maturity is not regarded as constituting an urgent disease risk and could be harvested for fibre if a suitable decorticator becomes available within, say, a year. Otherwise, it should also be destroyed with the exception of about one acre which could be left for seed production until enough seed has been obtained to regenerate sufficient of the variety. When this has been obtained the seed plot should also be destroyed. It is possible that small lots of abaca planting material have been distributed from Keravat to other parts of the Territory and it is recommended these be sought out and destroyed. There was a report that an introduction of abaca was made from the Philippines or Borneo by Mr. Alfred Evensen (now deceased) to Pondo (New Britain) in 1937 and that some of this introduction was planted out after the war in a coconut plantation. The writer did not have time to investigate this report, but it is considered it should be followed up by an Agricultural Officer as soon as possible. The report is stated to have originated from a Mr. Lewis Searle.

Prospects of Establishing the Abaca Industry in the Territory.—

The world shortage of abaca and the present high price have been caused by upset of the industry in the Philippine Islands (4, 16) which prior to the war accounted for 97 per cent. of the world's supply. In 1939 abaca was grown on 722,000 acres in the Philippines and a few thousand acres only were grown in North Borneo, Sumatra and Central America. The main centre of production in the Philippines was in the province of Davao in Mindanao, which in 1940 produced 53 per cent. of the abaca export. The industry there was controlled by the Japanese, who operated well-managed estates. In most other parts of the Philippines, e.g. the Bicol region of Luzon and the Visayan Islands of Leyte and Samar, tenant farmers produced most of the abaca and the conditions of tenure were rather

severe, the landlord usually taking more than half the crop as rent. The industry has not recovered since the War. The banishment of the Japanese led to disorganization of the Davao Estates and the rebellion against landlords and the post-war demand for food crops have interfered with peasant production of abaca. Philippine exports of abaca are now less than 50 per cent. of pre-war and general opinion is that the Philippine abaca industry will take many years to recover.

Central America (Costa Rica, Guatemala, Honduras and Panama) enlarged its production of abaca during the War, but it appears that a good deal of unsuitable land was planted and in spite of full U.S. Government support and the use of mechanical methods, it is doubtful if the industry is yet well established. It is clearly the desire, however, of the U.S. Government to push on the industry in Central America and recently a further allocation of $35,000,000 was made for this purpose. The U.S. Government's abaca interests in Central America are being managed by the United Fruit Company.

The abaca industry in North Borneo is still very small and has recently gone through a severe outbreak of bunchy top and the estates are being replanted. It is understood that little or no progress has been made since the War with the Sumatran industry.

The market prospects for abaca fibre must be regarded as good. The current price of the fibre is about £A300 per ton and it seems that the only fair substitute for it for marine cordage is nylon at more than £A1,000 per ton. Sisal fibre has, however, been substituted fairly satisfactorily for abaca fibre in many cordage uses other than marine.

The prospects of cultivating abaca in the Territory of Papua and New Guinea are considered also to be fairly good, provided sufficient capital is put into the scheme and the right locations for the plantations are chosen. Ample capital would be necessary because it would not be payable to extract the fibre by the peasant methods used in most areas of the Philippines. Machine extraction in factories would be the only method worth considering and this would call for the lay out of plantations with narrow gauge railways as used in the sugar industry. Depending on the size of the project the factories would be equipped with either batteries of hagotans or more extensive equipment such as Krupp decorticators. It would be important to select correct localities for the plantations because high soil fertility and regular rainfall are necessary for high fibre yields and as the product is bulky and non-seasonal, this would call for roads and all-weather shipping ports.

It is considered that soils of geographically recent volcanic origin would prove the most suitable and while there are extensive areas of such soils in the Territory, there is a restriction on availability imposed by the land requirements of the Native population. Many areas also would be left out of early consideration because of inaccessibility.

It is considered that it would be possible to establish the abaca industry in the Gazelle Peninsula of New Britain but it would be difficult there for commercial interests to acquire large areas of arable land in the one locality and it is thought also that cocoa will prove much more suitable as a crop for future development in this region.

The writer was impressed by the extensive areas of arable and sparsely populated land which make up the foothills and slopes of Mount Lamington in the Northern Division of Papua. The slopes extend almost to the Coast towards Gona, Buna and Oro Bay and consist of uncleared jungle and many thousands of acres of relatively level land occupied by kunai and crotalaria. These foothills and slopes occur in the 100 to 150 inch rainfall belt and their soils are derived

from pumice dust from earlier eruptions of Mount Lamington. The soils in the jungle areas have been derived directly from pumice *in situ* but the kunai lands have been formed as silted-up river beds of the numerous watercourses that rise around the slopes of Mount Lamington. There seems little question that abaca could be grown successfully as a crop if the land now occupied by jungle were used, but it is not possible to assess the value of the vast areas of kunai land that occur in this region without experimental plantings. An Agricultural Station was established on kunai land at Popondetta shortly prior to the recent eruption of Mount Lamington and parts of this area which were inspected indicated by the vigour of annual crops that the kunai soil was of moderate to high fertility. It is not possible to forecast, however, whether such land would be suitable for a perennial crop such as abaca. Should trials, however, establish the suitability of kunai land for this crop the great expense of clearing jungle would be avoided.

It is recommended that trial plantings of abaca (selected seedling stock) be made in both jungle and kunai land in the Popondetta and other convenient areas in the Mount Lamington slopes. The land which, because of present road, bridge and port development, would seem well suited for establishing plantations, particularly should kunai soils prove suitable to the crop, is that which lies between the Giruwa and Amboga Rivers. A small port connected by road with this land is being constructed at Port Killerton and excellent airstrips are available at Inonda and Embi for flying in labour lines.

Time did not permit an inspection of the volcanic soils of the Wanigela-Sinapa areas where considerable areas of land are available for agricultural development.

The provision of labour for operating large abaca plantations in Papua New Guinea could quite well prove the main difficulty, and it is thought this question would need the closest examination. In spite of the best mechanization, a large labour force would still be required for the preparation of land, planting, weeding, harvesting and for factory work. The writer is unable to provide an estimate of the amount of labour which would be required for a mechanized plantation, but the following figures show the size of the labour force which was necessary to operate two plantations, " Tiger " and " Table " which were established near Tawau, North Borneo, by the Japanese in pre-war days. These plantations used batteries of hagotans in the factories for extracting the fibre.

Tiger Estate, 1941.

Total area cleared		4,719 acres
Area planted, mature	1,555 acres	
Area newly planted	392 acres	
	——	1,947 acres

Labourers : 300 Japanese, 800 Malays and Chinese.

Table Estate, 1941.

Total area cleared and planted .... 2,200 acres.

Labourers : 300 Japanese, 800 Malays and Chinese. 660 were employed in fibre production and the remainder for felling jungle, operating saw-mills and other works.

The provision of labour appeared, to the writer during his visit to the Territory, to be the most discussed question among plantation owners. In most areas local labour seems unsuitable or is unorganized and unprocurable, and the copra, rubber and cocoa industries depend largely on the " importation " of labour lines from the Central Highlands and Sepik areas. If the abaca industry were to be established

in the Mount Lamington region, or in nearly any other part of the Territory, it is thought that imported labour would need to be depended on, and the costs involved would need to be taken into consideration.

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HOME PRESERVATION OF FISH IN TROPICAL CLIMATES

By K. W. Anderson.

(Mr. Anderson visited the Territory as an Officer of the Food Preservation Division of C.S.I.R.O. to make a survey of fish preservation problems.)

THE intention in this article is to suggest some methods for the preservation of fish which may be useful to isolated European communities in New Guinea and Papua in smoothing out fluctuations in the availability of fresh fish.

Biochemical Basis of Fish Preservation.

Spoilage in fish is caused by :—

1. Bacterial Activity—

The flesh of newly caught, healthy fish contains no bacteria. However, the external surface, slime, gills and gut contain large numbers which invade the flesh soon after death. The rate at which they multiply increases with the atmospheric temperature. Bacteria attack the proteins giving rise to obnoxious breakdown products such as ammonia and sulphuretted hydrogen and also reduce a chemical substance, trimethylamine oxide, contained in the flesh of all salt water fish, to trimethylamine which is a gas and partly responsible for the particular smell of stale fish.

2. Enzymatic Activity—

Enzymes are non-living chemical ferments responsible for many biological processes. Those occurring in the gut of fish are particularly capable of the chemical breakdown and digestion of food. Shortly after death they begin to digest the flesh producing the typical softness.

3. Oxidation—

Oxygen of the air reacts with fats in the fish producing rancidity with its typical, bitter off odours and flavours.

The Methods Employed in Controlling this Spoilage are—

1. Temperature—

The use of heat, as in canning, to destroy bacteria and enzyme activity completely, or of cold, as in chilling, freezing and cold storage, to inhibit their development.

2. Chemical—

The use of salt, vinegar or smoke constituents which render the fish flesh, in varying degree, unsuited as a medium for bacterial growth and enzymatic activity.

3. Drying—

Bacteria cannot grow in foodstuffs with a moisture content less than 40 per cent. Some moulds can grow down to 16 per cent. water content.

Time Lag Between Catching and Processing.

In the light of the foregoing remarks it becomes fairly obvious that one of the most important phases in curing work is to obtain the fish as soon as possible after catching—before incipient spoilage has already set in. In the absence of ice it is

essential to thoroughly clean and wash the fish, scrubbing off blood and slime with a stiff brush immediately after capture, and to store it in as cool a place as possible if immediate processing is not possible. Rough handling and bruising of the fish should be avoided. The maximum permissible time lag between catching and application of a cure under tropical conditions is a few hours.

Curing.

The curing of fish can be divided into two distinct classes :—

1. A light cure where the initial characteristics, i.e. appearance, texture, flavour, is little changed by the treatment. In general such cures are suited to cool climates and the products have short storage lives unless kept under refrigeration.

2. Heavy cures where the rather drastic treatment considerably alters the former characteristics of the fish and lowers its palatability. The products may, however, have a life of some weeks or months even without cold storage and under tropical conditions.

Light Cures.

A. Brine Salting—

1. Preparation of Fish :—Small fish are split either down the back or belly and opened out so as to lie flat in one piece. Sometimes it is necessary to cut under the backbone and score the flesh at intervals of an inch or so, with the point of a knife, thus providing a greater area of cut flesh for penetration of salt into the tissue. The gills are removed from the split head, or the head removed completely. Large fish are split into two fillets removing the backbone but leaving the collarbone just below the gills to keep the flesh from falling apart during processing.

Reduce the fillets in size so that they will lie flat in the salting vessel and if necessary score the flesh longitudinally to a depth of $\frac{1}{2}$ inch at 1-2 inch intervals without piercing the backbone.

Thick skinned, spiny finned fish with large scales should be skinned and the fins removed by making a deep cut along each side of the fin and pulling it away by hand.

The fish are then thoroughly washed and scrubbed with a clean stiff brush in fresh water followed by soaking for 30 minutes in a dilute brine (a half-cup of salt per gallon of water) which helps to remove blood and cut slime from the fish.

2. Brining :—Rinse the fish quickly and place them into a brine containing 2-2$\frac{1}{2}$lb. of salt per gallon of water. The brining vessel should be watertight and of non-corrosive material. A small dugout canoe would probably be suitable. Cover the fish with a loosely fitting wooden cover weighted down so that they remain below the surface of the brine. The time required is dependent on the thickness of the fillets and number of layers of fish. For half-inch fillets in two or three layers one to three hours should be ample. For larger fish and larger quantities the time must be extended.

Remove the fish, drain them quickly and immediately place in shallow containers with good fitting lids in the refrigerator.

B. Marinating—Curing with Vinegar, Salt, Sugar and Spices—

1. Preparation and cleaning is the same as for brine salting.

2. Marinating :—About 10 lb. of fillets are immersed in a solution prepared as follows—Distilled White Vinegar, 1 gallon ; Salt, 1 lb. After 24-36 hours in the pickle the fillets are washed, drained and trimmed, arranged closely together on a flat surface skin side down and the following spice mixture spread evenly over their surface at the rate of a-half ounce per one pound of fish—Whole Allspice, 10 parts ; Whole White Pepper, 8 parts ; Whole Mustard Seed, 4 parts ; Whole Cloves, 1 part ; Bay Leaves, 1 part ; Ginger, 1 part. Roll the fillets from the tail, if desired around a small piece of dill pickle or an onion, and fasten with a tooth-pick. Pack them tightly in wide-mouth glass jars. Metal covers should have a protective disc to prevent corrosion of the metal by acid sauce. Onion slices, lemon or pimento can be added if required.

The jars are then filled with the following sauce, making sure that the fillets are completely covered—Distilled White Vinegar, 4½ pints ; Salt, ½ lb. ; Sugar, 5 oz. ; Water, 3 pints. Seal and store the jars in a refrigerator.

White distilled vinegar is preferable to brown and fruit vinegars which contain tannin and may produce off flavours. The selection of spices and garnishings are left to the consumers preference and their availability. Whilst the fish can be eaten immediately a " cured " flavour develops after one to two weeks.

C. Smoking—

Light smoke curing, whilst imparting a desirable flavour to fish, is difficult to control and apply in tropical climates.

1. Preparation of the fish and cleaning is as before.

2. A preliminary brining in which the fish are soaked for a half-hour in a brine containing 2 lb. of salt per gallon of water. After removal from this brine bath they are rinsed in a dilute brine (half-cup of salt per gallon of water) and allowed to drain. The fillets are then placed on wire trays or preferably suspended from hooks inside a simple smokehouse so that they do not touch.

3. It will probably be necessary to hot smoke the fish at 130°-150° F. for at least five hours.

A smokehouse of limited capabilities can be constructed from a large wooden box, metal or wooden barrel with the ends out. It is placed over a pit about two feet deep which at the side opposite the door extends beyond the smoker to form a firepit. The firepit has a cover to control the fire and force the draught with the smoke into the smokehouse. The top of the smoker is covered, with the exception of an adjustable crack to permit escape of smoke and maintain flow through the system.

Sawdust is preferable because of its tendency to smoulder without bursting into flame but wood chips can be used. The best woods are non-resinous soft-woods and some hardwoods. Green coconut husks are satisfactory.

Allow the fish to cool and store, without stacking or wrapping, in the refrigerator.

D. Pickling.—Combined Cooking and Marinating—

Pickled Eels.

Clean and skin the eels and cut into pieces about a-half inch thick. Wash, drain, and dredge in fine salt, allow to stand one hour. Rinse off the salt, wipe the pieces dry, and rub with a cut clove or garlic or onion. Brush with melted butter or salad oil and broil until the surface is light brown. Place the pieces of eel on absorbent paper and when cool pack them in layers in a crock with a scattering of spliced onion and spices between layers of fish. Weigh

the mixture down to keep it compressed and store in a refrigerator for 24 hours. Then cover with distilled white vinegar. Seal the crock tightly and store in the refrigerator. Allow to stand 48 hours before using.

Typical quantities for 10 lb. of eels are as follows :—Distilled White Vinegar, 2 quarts; Allspice, 1 oz.; Bay Leaves, 1 oz.; Mustard Seed, ½ oz.; Cloves, ½ oz.; Black Peppers, ½ oz.; Mace, ½ oz.

Pickled Clams, Oysters, Mussels.

Clean the shells and steam to open. Save the liquor or nectar. Remove the meat from the shells—cool meat and nectar separately. When cool, pack the meats into sterilized (boiled) jars with a few bay leaves and whole cloves. Add a slice or two of lemon to each jar.

Strain the nectar obtained in steaming. To each quart of this add—Distilled White Vinegar, ¾ pint; Cloves, teaspoon; Allspice, ½ teaspoon; Red Peppers, ½ teaspoon; Cracked, Whole Mace, 1 teaspoon. Simmer for 45 minutes.

When cool pour into the jars and seal. Store in the refrigerator. Note that these products become dark in colour when exposed to the light.

Pickled Shrimp-Prawns.

Peel the shrimp or prawns and wash them well. Make a pickle as follows—Water, 7¼ pints; Salt, ½ cup; Distilled White Vinegar, 1¼ pints; Red Peppers, 1 tablespoon; White Peppers, ½ tablespoon; Allspice, ½ tablespoon; Mustard Seed, ½ tablespoon; Bay Leaves, 6 leaves. Simmer the pickle slowly for a-half hour, then bring to the boiling point, add the shrimp or prawns and bring back to the boil. Cook for five minutes. Remove them from the brine and allow to cool. Pack in sterilized jars with a few fresh spices and a slice of lemon in each jar.

Fill the jar with a solution made from—Distilled White Vinegar, 2 pints; Water, 1¼ pints; Sugar, 1 tablespoon. Seal the jars and store in the refrigerator.

Storage Life of Light Cures.

Under the conditions of temperature normally found in household refrigerators (35°-45° F.) these light cures, if properly applied, should yield storage lives of from several weeks to months.

Reconstitution of Light Cures.

Reconstruction is accomplished by soaking in several cold waters until the required degree of leaching is obtained. The fish can then be cooked in any conventional manner. Note that hot smoke and pickle cures are already cooked. Some people prefer not to leach marinated, spiced fish.

Spiced Fish.

Sun drying to a low moisture content is not feasible in tropical climates and fire drying is hard to control, generally leading to a product of poor texture and palatability.

Dry Salting.

Preparation and cleaning of the fish is the same as for brine salting.

The split or filleted fish are then dredged in a box of curing salt, picked up with as much salt as will stick to them and stacked in layers skin side down in a non-corrosive, watertight container. A thin layer of salt is placed along the bottom of the salting vessel and between each layer of fish. No two pieces of fish should touch and each layer is laid at right angles to the preceding one. The amount of salt necessary will be approximately 30 per cent. of the weight of fish. The top layer of fish is packed skin side up and weighted down with boards to

prevent the fish floating in the brine that subsequently forms. For small batches (20 lb. of fish) at least 24 hours will be required for sufficient cure. Thicker fish and larger quantities may need seven days or longer.

Rinse the fish in a fresh dilute brine (½ lb. salt per 5 gallons of water) to remove adhering salt and place them on a wire-framed drying rack preferably in a breezy, shaded location as sunlight accelerates oxidation of the fats.

Air dry the fish until there is no further sign of surface moisture, nor any visible, when pressure is applied with the palm of the hand. The time required will depend on weather conditions and may vary from a few hours to days. In periods of rain and at night (when the relative humidity of the atmosphere rises), the racks should be removed to a sheltered spot and covered with a tarpaulin.

If desired the salted air dried fish can be smoked in some simple kiln as previously described. It is permissible to use much lower smoke temperatures with this heavily salted product thus avoiding further tendency to toughen the flesh.

This product can be stored without refrigeration and should keep at least several weeks. It will develop surface moisture but this cannot be avoided. An occasional redrying or packing of the fish in dry salt is suggested.

Reconstitution is as for light cures. Subsequent cooking should be brief as the effect of the heavy salting is to toughen the flesh.

Some Notes.

1. The higher the quality of the curing agents the better the product. Salt should be at least 98-99 per cent. pure, clean and dry as possible and of fine crystal size for dry salting. An excellent salt is " Flossy " curing salt—a product of the Cheetham Co., Geelong. Approximate price, Sydney, 20s. per 186 lb. bag.

2. One of the commonest sources of spoilage in salt fish is due to halophilic bacteria—organisms which can grow in concentrated salt solutions. It occurs as pink or red brown stains on the fish accompanied by softening and putrefaction. If it is encountered, all equipment and benches should be disinfected and the salt roasted in shallow trays over a fire to sterilize it. Salt obtained from the sea by solar evaporation is often contaminated with these bacteria.

3. Many of the spice mixtures and garnishings described can be used to advantage in flavouring salted or fresh fish during cooking.

4. Where commercial, low temperature refrigeration is available a simple and efficient preservation of fresh fish can be obtained by placing the cleaned fillets into a cut down kerosene tin, covering with water and freezing to a solid block of ice.

5. Australian and English white distilled vinegar is usually, unless otherwise labelled, 16 grain strength—4 per cent. acetic acid. Quantities have been calculated on this basis. Some American white vinegars are 100 grain strength—10 per cent. acetic acid. The American " grain " unit differs from the English.

Bibliography.

Information on Marinating was gathered from—Progress Reports of the Pacific Coast Stations—Canada 58, p. 20 (1944) ; Progress Reports of the Atlantic Coast Stations—Canada 48, p. 12 (1950).

Information on Pickling is contained in : Home Preservation of Fishery Products—Jarvis ; U.S.A. Dept. of Interior, Fish and Wildlife. Fishery Leaflet 18 (1943).

ROTARY CUTTER SUCCESSFULLY DEMONSTRATED IN TERRITORY

LATE in 1953 a rotary cutter for clearing and maintenance work was successfully demonstrated in Port Moresby, Lae and Rabaul.

The active unit in the cutter is a set of rapidly rotating horizontal scythe blades adjustable for cutting height and mounted under a very effective protective housing. The cutter is tractor-drawn and p.t.o. driven, and the model demonstrated was for linkage with a 30 h.p. tractor.

At a Field Day held by the Department of Agriculture, Stock and Fisheries at Laloki, and attended by representatives of the planting industry and the Departments of Forests, Works, and Civil Aviation, the cutter successfully dealt with secondary bush and native grass growth, including seedling trees up to four inches in diameter. It was generally agreed that for all except the lightest work, such as airstrip maintenance, the cutter would need to be equipped with heavy duty blades for conditions in this Territory, also that for coconut plantation work a cow-catcher or similar device would be needed to prevent the destruction of ripe nuts on the ground. A feature of the work of the machine was the finely-chopped even deposit of vegetable matter left in its wake.

The machine described, a Woods Cutter, was demonstrated by Hastings Diesels Ltd.

View of the cutter at work in secondary growth being drawn by 30 h.p. International AW.6 tractor.

Finely chopped material left in the wake of the cutter after passing through the secondary growth.

Visitors at Laloki Field Day inspecting the work of the cutter.

Rural Broadcasts:

I.—NATIVE AGRICULTURE AND NATIVE PRODUCTION

WITH the exception of some small and strictly limited groups, the Native population of the Territory is dependent for subsistence on the production or collection of various vegetable foods. Although the methods used are essentially primitive, they are by no means unsystematic, and although variations are found with varying environmental conditions, it is not difficult to detect an overall similarity of method.

Of prime importance in the Native system is the production of the staple foodstuffs, invariably a starchy vegetable. Sweet potato, taro, yams, sago and bananas are the main crops of this type, and varying with the environment one or other of them is usually dominant to a marked degree in the agriculture of a particular community. Cassava is the most important accessory starch food crop, while any one of several of those mentioned above may also be grown as accessories.

Both wild and planted stands of sago palms are widely distributed in the extensive low-lying swampy areas associated with the larger river systems. All the remaining staples are treated as annuals, and the basic unit of cultivation is a small garden clearing cut from forest or grassland; interplanting of other annuals such as maize, sugar-cane and pit-pit is not uncommon, but is rarely done systematically. With the exception of some limited areas of high fertility, these gardens are abandoned after a single cropping, and are allowed to lie fallow for as long as the local population pressure will permit, with the usual variants such as accessibility and floodability operating. This period of fallow is sometimes long enought for high secondary jungle to develop before the cultivator returns to such a plot—the system has accordingly earned the appropriate name of " Bush Fallowing Rotation ".

A number of perennials are also commonly grown for food usually as fruits or nuts. The practice is to locate them in irregular groves, usually associated with places of habitation. Of these the most important are the coconut palm, bread-fruit, betel-nut palm, and the mountain pandanus.

Livestock do not play an important part in the land use methods of the people. Pigs and fowls are the only types kept, and the methods of husbandry are primitive. Stock are rarely enclosed, but are mostly allowed to roam free in the habitated area. Hand-feeding is irregular and aimed more at keeping the animals domesticated, than providing them with any definite dietary level. The eating of pig meat is confined almost universally to ceremonial occasions. The typical Native fowl is small, lean and leggy with variegated plumage—it has a very low egg production rate, and is prized principally for its coloured feathers. Dogs are kept as household pets and for hunting and sometimes figure as a source of meat, although this practice has been dying out with the extension of European influence.

The principal economic factors affecting Native agriculture in Papua and New Guinea are (1) the generally low population density, (2) the low degree of technological development associated with food production and (3) the limited scope for export and trade provided by local political and geographical conditions. The extensive long-fallow type of land use method which has been described is only possible where the available acreage per head is high, but it must be remembered that a considerable portion of the land so employed is for topo-

graphical and climatic reasons of dubious value under any other type of cultivation, The implements used are simple—axes and knives for clearing, and the digging stick and the hoe for cultivation. Inevitably burning is widely used in clearing and has a special significance in that it raises the initial level of available potassium in garden soils. Crude irrigation systems are found very occasionally, while fertilizers and manures are virtually unknown.

As with most peasant people women play an important part in agricultural production and the sharp sexual division of Native communities is reflected in agricultural methods. With minor variations in particular communities, certain tasks are invariably regarded as the work of one or other sex. The heavier work such as felling and clearing jungle falls to the men, while the lighter but more tedious jobs such as planting, weeding and harvesting are the women's responsibility. Under primitive conditions this division of responsibilty is strictly observed and is reinforced by taboo.

In the wet, swampy lowlands and in the tropical rain forests of the foothills and lower mountain slopes the forest vegetation is extremely diverse, a variety of trees and palms with edible fruits, foliage, or pith, occur and collection becomes an important factor in food-getting with cultivation showing limitations accordingly. This is particularly the case in some of the larger river valley plains and in the Delta areas. The sago palm grows readily in semi-inundated areas and species of edible fruits, nuts, and leaves occur in the forests. Additional foodstuffs are available in the form of edible fungi, the hearts of tree ferns, palms and the young unopened fronds of nipa palm.

Taro is the characteristic staple food crop in lowland rain forest areas of moderate fertility, and in its cultivation the surface soil is least disturbed. The forest is cleared and the garden area may be lightly burned over, after which the taro shoots are planted in cylindrical holes of no great depth made with a pointed stick. The soil around the top of the holes is tamped in tightly and the taro plant is then left to mature, with perhaps a light weeding from time to time. Yams are typical of better drained soils of high mineral fertility such as the new volcanic soils of the Prince Alexander and Torricelli Mountains and of some of the smaller volcanic islands such as those lying to the south-east of Manus and also of the richer soils derived from coralline limestones as in the Trobriand Islands. The soil is deeply worked in preparation for planting, and the area around the base of the yam vine receives considerable attention during the growth, the soil being kept loose to facilitate the best development of the tubers. Sweet potatoes are the main crop of cooler upland areas and in their cultivation the whole of the garden topsoil is usually broken up with digging implements and then scooped up into planting hills or mounds. Bananas become an important crop in areas with a pronounced dry season such as the belt stretching along the coast of Papua to the east and west of Port Moresby. Cassava is salt-tolerant and sometimes becomes an important subsidiary crop in estuarine areas.

Under the guidance of the Department of Agriculture, Stock and Fisheries, improvements have been made in Native agricultural methods, particularly with the introduction of new crops of nutritional value and the introduction of permanent cash crops.

Native agricultural production now covers a wide variety of commodities, including copra, cocoa, coffee, peanuts, rice and vegetables. The monetary value to the Native people from copra alone is estimated at over £1,000,000 and this would be greatly increased when the other commodities are taken into consideration.

Officers of the Department of Agriculture, Stock and Fisheries have been stationed in specific areas to assist the Native people in the development of cash

crops and improvement of subsistence crops and at the present moment much work is being done with rice in the Mekeo, Madang and Sepik Districts.

The Native cocoa project in the Gazelle Peninsula is now estimated to have half a million trees planted and this industry, when the trees reach maturity, will provide an income of hundreds of thousands of pounds to the Native producers. Native coffee is also being produced in the Northern District, the Morobe District, and in the Highlands, and there is every indication that the Natives of these and other areas will increase their planting of cash crops to improve their economic standing.

The production of peanuts by Natives on a commercial scale is comparatively new in the Territory; however, there have been several tons produced in conjunction with rice growing which has sold well on the Australian market.

The production of vegetables is a major cash earner for the Native peoples in Rabaul and Lae, who supply most of the population with their requirements of European vegetables, through local Native controlled markets. Production of Native root crops, such as sweet potatoes, taro, etc., is also a great money earner when they are sold to plantations and other private and Government institutions for Native rations.

The introduction of new and nutritionally desirable crops to the Native people is the responsibility of the Department of Agriculture, Stock and Fisheries and work is continually going on in the extension service to bring approved crops to Native peoples.

It is appropriate in concluding this talk to say a few words about the future for the Native agriculturalists in this Territory. At the present time, generally speaking, the Native farmer is neither a true peasant with permanent cultivation on a relatively limited subsistence area, nor is he a truly nomadic cultivator although the principles of rotation, which he follows, involve the movement of his gardens over quite wide areas and long periods of resting fallow. His holdings of land are relatively high for Native peoples in the tropics and will remain so even if considerable areas are devoted to European development. We feel that his future as an agriculturalist will depend largely on what both private enterprise and the Government can do during the next two or three decades to teach him to employ more efficient methods of land use than he has at present.

The big danger from the point of view of efficiency is that with the extension of Public Health facilities resulting in population increase, if no forward steps have been taken in the meantime and the present system is still the best one available then the result will be fragmentation of agricultural holdings to such small size units that it will be impossible to improve their standard of efficiency. This is the position and the tragic one throughout many parts of the tropics at the present time but in this Territory there is an excellent opportunity to avoid it.

II.—LAND TYPES AND THEIR USES IN PAPUA AND NEW GUINEA

WE are introducing here a very wide subject and one about which it is never possible to be dogmatic. It is a subject, however, which would well repay careful attention both by established planters and farmers and by people intending to settle on the land in the Territory. In a previous broadcast on agricultural development, we pointed out that the Territory with its many

islands, its towering mountain ranges and its great river systems, provides an extremely wide range of environments and accordingly diverse opportunities for agricultural and pastoral development. It is this very diversity which makes our present subject a difficult one in which to generalize. It is necessary to find some sort of a basis for classification in order to gain an approach to our discussion and first and simplest is by altitude, into lowland regions, mid-altitude regions and mountain regions. Any boundaries chosen are arbitrary and will never be found to result in climatic or other environmental conditions which are fixed or predictable for a given altitude, but generally lowland areas are considered to range from sea-level to various altitudes from 500 feet to 1,500 feet, mid-altitude or mid-mountain regions from these upper limits to about 3,500 feet and mountain areas above 3,500 feet. It is interesting to note that a fourth type of region, the alpine, is found on our highest mountain ranges on the great peaks such as Victoria, Albert-Edward, Saruwaged, Wilhelm and Hagen. In the adjacent Territory of Dutch New Guinea there is an area of permanent snow-line with a small glacier.

Taking the lowland region first, we can divide this into the tropical forests which are of the rain forest and monsoonal forest type, grass plains and the swamp land. The lowland forests are characteristically tropical in the generally accepted sense and give us the typical plantation setting, such country being usually best adapted for the cultivation of tree crops such as coconuts, cacao, rubber, robusta coffee, oil palm and Manila hemp. They are indicative of high rainfalls generally without a very clear season.

Deforestation and the annual crop type of farming as a permanent industry is to be avoided in this sort of country. Annual crops may be considered as pot-boilers, or, as they are sometimes known, as catch crops, to provide some money income from cleared forest land while tree crops are coming into bearing. However, they do not provide the soil protection that one gets from the canopy formed by a permanent crop or from accepted cover cropping practices and under the high rainfall conditions soils will leach and lose their fertility very rapidly.

Care has to be exercised in selecting plantation land in rain forest country as the overall forest cover tends to mask such undesirable characteristics as thin soil over rock, very heavy clay soil or an excessively sandy soil. The best plantation lands in this zone are usually found in the alluvial areas along river valleys, the volcanic belts such as on the North Papuan Coast and in New Britain and Bougainville and on the coastal coral limestone platforms. This last category of soil, the coral limestone, often proved suitable for coconut production but must be regarded as a dubious type for many other crops. In some cases, as in the coastal areas between Madang and Bogia, the soils near the coast consisting of old beach sands, are fertile, due to the action of off-shore volcanoes.

In the major inland valleys such as the Markham, Ramu and Sepik, and in those parts of the coastal region where a flat or gently sloping plain tends to stretch for some distance inland, as is found in places along both the North and South Coasts of Papua, the climate tends to be drier with a sharply marked dry season, and extensive grass plains occur. These have the attraction from the point of view of development, that clearing costs are minimized, and that the Native grassland will support grazing stock, in particular, cattle. Very little is known of the possibilities of these grasslands for permanent cropping, and the experience we have to date is not encouraging. However, they do seem to be a natural site for the development of grazing industries, and of farming with annual crops such as sorghum, rice, peanuts, castor bean, kenaf, cotton and maize.

Where cropping is to be considered on these grasslands, there is again a need to exercise care in selection. Experience has shown that the best soils in the grasslands, both from the point of view of their fertility and their structure, carry an annual cover of true kunai grass. This may often be confused with similar broad-leaf grasses, but is easily distinguished once its pure white, bull-rush shaped flowering head is recognized. The very light soils in this type of country are to be avoided because of the danger of wind erosion once cultivation is commenced. Considerable areas are found in these tropical grass plains with a cover of the tall cane grass, or sirio grass, which is easily recognized by its upstanding spear-shaped flower heads. Such land, after rolling or chopping, is often of use for cropping, but expert advice should be obtained when this is considered. The grass very often indicates an excessively sandy and raw type of soil with a poor nitrogen content.

Rice culture in the plains country of New Guinea needs special consideration; at the present time only dry rice is grown in this country. However, in a permanent industry, particularly if it is to be capitalized by European growers, irrigation must be taken into account, since the yield is so much greater. Dry-grown rice might well be considered as a possible crop for the more porous soils during early stages of bringing an area under cultivation or as a rotation crop for others, such as peanuts, kenaf, etc. Although odd patches of country throughout the Territory will undoubtedly prove suitable for irrigation, the only major well-known belt of water retentive soils at the present time is that in the Ramu and Sepik Valleys.

In dealing with the grasslands, special mention should be made of the belts of rolling low country found along the Southern Coast of Papua. The soils in these areas are more typical of Australian grazing land, with their scatter of small Eucalypts, a predominance of Kangaroo grass and a tendency to be low in phosphates, and grazing, particularly for cattle, must be consideed as the prime use.

At the present stage of development in the Territory, little consideration is being given to the swamp areas found associated with the big river valleys, but it must be remembered that such areas have been the scene for major agricultural developments in other parts of the world, particularly tropical Asia. Such lands have a very high potential for carbohydrate production in the form of the sago palm and rice, where water movements can be readily controlled by bunding and similar methods, and they lend themselves to the development of pond fisheries.

The mid-mountain regions have, to date, attracted comparatively little interest, as in this Territory they are usually areas of steep slope and high rainfall. Very often too, the rock types outcropping at these levels are of the sedimentary and metamorphic type, which give rise to soils of only medium or low fertility. Some important exceptions are where the general rise of the country is broken by plateaux at medium elevations, as in the case of the Koitaki-Sogeri Plateau, inland from Port Moresby, and sections of country inland of Abau in Eastern Papua. A fertile volcanic plateau also occurs on the Gazelle Peninsula of New Britain. Some rivers in cutting back from the coast, have developed extensive valleys at the mid-mountain level, such as the Yodda Valley in Papua, and these have scope for development. In some cases, as in the elevated pumice belt of the Gazelle Peninsula, this medium altitude country will carry the full range of tropical crops, while in Papua in the Yodda Valley and on the Koitaki Plateau it has proved to be well suited to rubber development. At the upper limits of the medium altitude belt, we have valleys such as the Wau Valley, where development of Highland crops such as Arabian Coffee, becomes possible. Generally speaking, for long term development the mid-altitude regions

where land conditions are suitable must be regarded as permanent crop areas and annual crops must have a short term function in their development.

There are extensive true mountain or upland belts, associated with the great ranges of the Territory, and particularly in the area known as the Central Highlands, that is, the mountain country from the Ramu headwaters, through towards the Dutch border to the west, there is an extensive development of valley and plateau formations giving country suitable for agriculture and stock raising. Coffee of the Arabica type or Highland coffee thrives in these regions, and a small industry has already grown up there. More temperate types of crops, such as Passionfruit, will also grow well, and an industry is developing rapidly, under stimulus of demand by Australian cordial firms.

Other temperate crops, such as various types of European vegetables, also do well, while pasture improvement and selective weeding of pastures, pays dividends, and it is possible to establish a fine grass sward of the type found in temperate zones. Particular care must be exercised in selecting land for cropping or grazing in these upland regions and all but the gentlest slopes should be avoided as should also the heavier clays and coarse sandy soil, since wind blowing on top soils, water erosion and consolidation of clays into pugs, are possible dangers at these high levels.

The Highland areas in the Territory are the only ones where there is a development of the peat type of soil and the possibility for cropping this must receive attention. Shallow drainage and cultivation giving aeration would probably make a great change in the cropping capacity of such areas and in other parts of the world it has been found that the application of small quantities of certain minor elements, notably copper, greatly assist in improving the general fertility.

Tea is another crop which is receiving attention for possible development in the Highlands although it is regarded as something more for the future than for immediate widespread development. The labour potentiality has to be built up and educated before there can be any major tea growing industry. Superior quality teas can be grown only in the Highland areas and the present position of tea on the world's market is that the bulk or lowland type is fully supplied but there is a strong demand for the superior quality highland grown types.

Rounding off our all too brief discussion on the subject of land types and their uses, it should be stated that areas other than those which are level or gently sloping should be considered very carefully before any type of development is contemplated. Then the location itself needs careful consideration in relation to the soil type, vegetation and the local climate, to determine its potentiality for any particular crop or crops or for other forms of land use such as grazing.

The Department of Agriculture, Stock and Fisheries will always be ready to advise on such matters to the fullest extent of its knowledge and experience.

NEW AND INTERESTING IDENTIFICATIONS

Helminthosporium Disease of Manila Hemp

By L. B. Thrower, M.Sc.*

During the past few months this Department has received several inquiries concerning the prospects of establishing the manila hemp plant, *Musa textilis*, on a commercial scale in the Territory. In May, 1954, a disease, stem rot, was diagnosed on plants at Bubia and, later, the same disease was found on plants at the Lowlands Agricultural Experiment Station, Keravat. The purpose of this short article is to present a description of the disease, and to consider its influence on the development of a manila hemp industry in Papua and New Guinea.

This disease, which is caused by the fungus *Helminthosporium torulosum*, was first recorded from Luzon (Philippines) in 1931 where it occurred in a severe form; later in the same year a milder strain was observed in Mindanao. No report has been found of a serious outbreak since that time.

The first visible symptoms of the disease are small brown spots about one-tenth of an inch in diameter which appear on the outer sheath of the pseudostem. These spots enlarge, darken and become slightly depressed below the surface of the sheath; enlargement is more rapid along the longer axis of the sheath so that the larger patches are usually elliptical. By the time the lesion is one inch long it is already visible on the inside of the sheath. Further expansion occurs by enlargement of the individual lesions and by coalescence to produce necrotic areas up to twelve inches long by three inches wide with a sparse growth of brown mycelium at the centre. Simultaneously, the pathogen penetrates inward toward the centre of the pseudostem, and in severe cases, may reach the fifth or sixth sheath so that the pseudostem collapses under the weight of the foliage; however, as seen in this Territory, the disease rarely penetrates beyond the second sheath. Badly diseased plants are useless for stripping and fibre prepared from less seriously affected sheaths has disfiguring brown patches corresponding to the position of the lesions; the effect of the disease on fibre strength has not yet been investigated.

In addition to causing stem rot of the manila hemp plant, *H. torulosum* is also associated with two diseases of the banana, *Musa sapientum*, namely "black end" and "black spot". The former is a fruit disease of relatively minor importance which has been recorded in Queensland, while the latter is a leaf spot that has caused considerable losses in the West Indies. The degree to which these two diseases are present in the Territory has not yet been investigated but, obviously, the presence of abundant alternative hosts, in the form of the edible banana, makes eradication of the stem rot organism an impossible task.

Observation of plants at Keravat and Bubia have revealed considerable individual variation in resistance to stem rot, and future work must combine selection of resistant types from material already available within the Territory with the breeding programme aimed at obtaining greater fibre strength and other desirable characters.

Finally, it must be emphasized that, although stem rot could cause serious damage to unselected plants, it does not constitute a problem comparable to that created by the two virus diseases, "mosaic" and "bunchy top", that have ravaged the manila hemp industry in other parts of the world. So far as can be ascertained, neither of these diseases is at present in this Territory, and every effort must be made to exclude them.

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* Plant Pathologist, Department of Agriculture, Stock and Fisheries.

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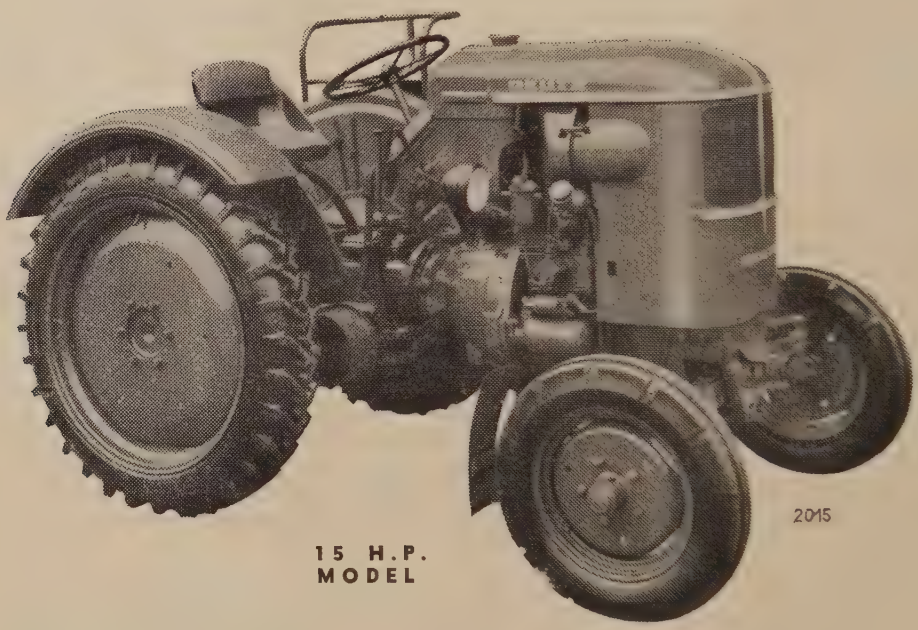

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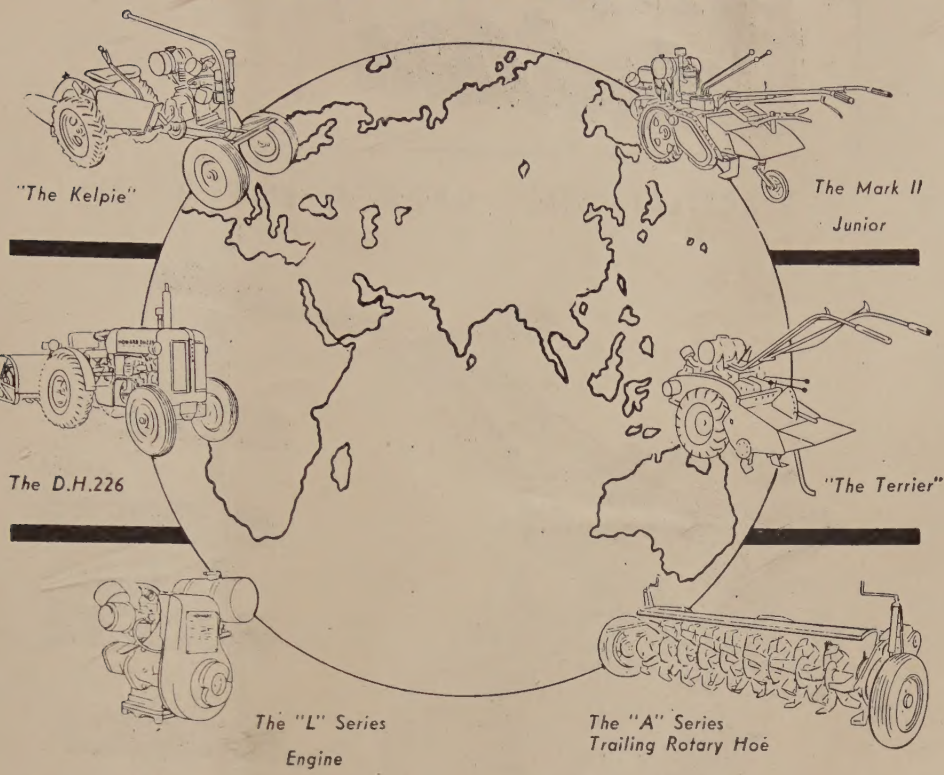

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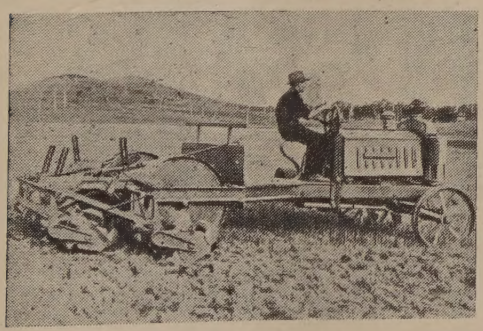

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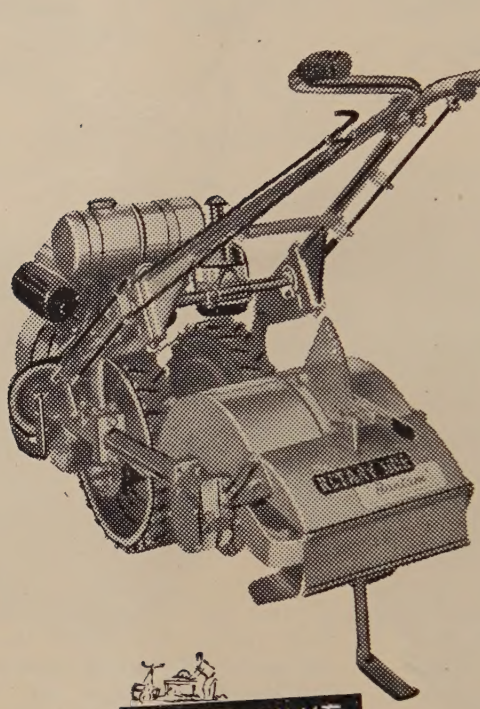

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